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The Ninth Report in a Series on
Efficiency in Fruit Marketing

WAGE PLANS AND EFFICIENCY IN GRAPE PACKING

B. C. French and L. L. Sammet

CALIFORNIA AGRICULTURAL EXPERIMENT STATION
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FOREWORD

This is the ninth in a series of reports on costs and efficiency in the marketing of deciduous fruits. It is concerned primarily with the following questions.

1. To what extent are packer productivity, packer earnings, and direct packing labor costs for packing fresh California Emperor, Tokay, and summer grapes affected by the wage plan used in paying the packers and by the proportion of cull fruit?

2. How do variations in wage plan and proportion of cull fruit and in the type of packing equipment affect the "indirect" costs of handling incoming fruit and culls and supplying fruit to the packers?

3. What effect does the packer wage plan have on the quality of the packed fruit and on the prices received?

The data pertaining to equipment capacities and rates of worker output on different jobs on which this report is based were derived from studies of actual plant operations and analysis of accounting record data obtained during the 1951 packing season. Cost calculations, however, are based on 1953 rates for wages, power, and other services and on replacement costs for equipment at the 1953 price level. The adjustments made to convert the 1951 wage rates to the 1953 level were small, in general not exceeding 5 per cent.

These studies were made cooperatively by the Giannini Foundation of Agricultural Economics of the Agricultural Experiment Station, University of California, Berkeley, and the Agricultural Marketing Service, U. S. Department of Agriculture. They were made under authority of the Research and Marketing Act of 1946 (RMA, Title II). This Act provides for studies of the costs of marketing agricultural products in their various forms and through the various channels and is designed to foster and assist in the development of more efficient marketing methods, practices, and facilities for the purpose of bringing about more efficient and orderly marketing and reducing the spread between the producer and the consumer.

Efficiency in Fruit Marketing

WAGE PLANS AND EFFICIENCY IN GRAPE PACKING

B. C. French[1] and L. L. Sammet[2]

The job of packing--trimming and placing fruit in boxes--represents the largest single component of labor cost in California grape packing houses. It is the central operation, and the productivity of the workers performing this job has an important influence on costs in other segments of the plant as well as on the direct cost of packing alone.

Studies of a sample of grape packing houses show wide variation in average packer productivity in different houses. Much of this variation can be explained in terms of the variety of grapes packed, the proportion of cull fruit, and the method used in paying the packers. The objective of this report is to determine the magnitude of these effects and to compare the different wage plans as to their advantages and disadvantages. The report contains a brief discussion of the nature of the packing operation. This is followed by a description of the wage plans used and an analysis of the effects of wage plan, proportion of cull fruit, and variety of grape on packer productivity, packing costs, and worker earnings. The effect of wage plan on the quality or condition of the final package also is discussed. The study is limited to house packing. No data are presented on field packing operations.

THE JOB OF PACKING

In the major part of the packing operation (illustrated in Figures 1, 2, and 3), the packer obtains field-run fruit from a picking box, trims out defective fruit, and places the trimmed bunches in the packing box. Minor elements of this job usually include obtaining an empty packing box and placing it on the packing stand, stamping the box with the packer's number, and placing or adjusting pads and liners. In some houses the packer also moves the packed box from the packing stand to the conveyor that transports it to the lidder.

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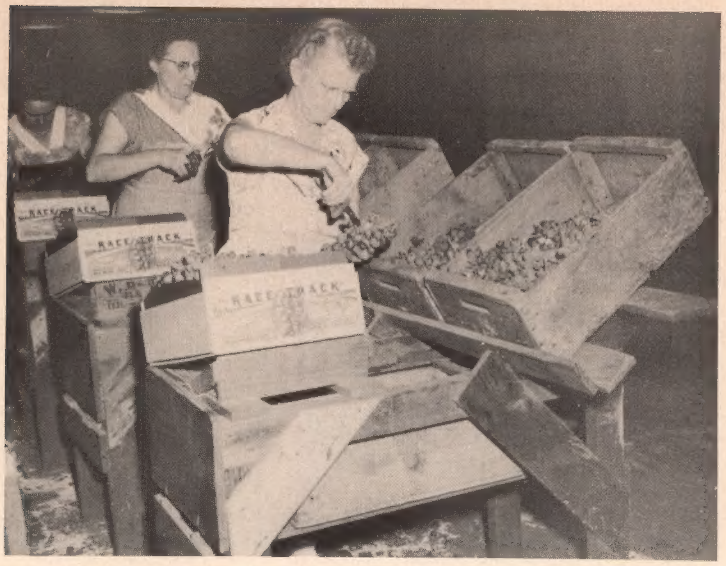

FIGURE 1. Packing stands, nonmechanized equipment

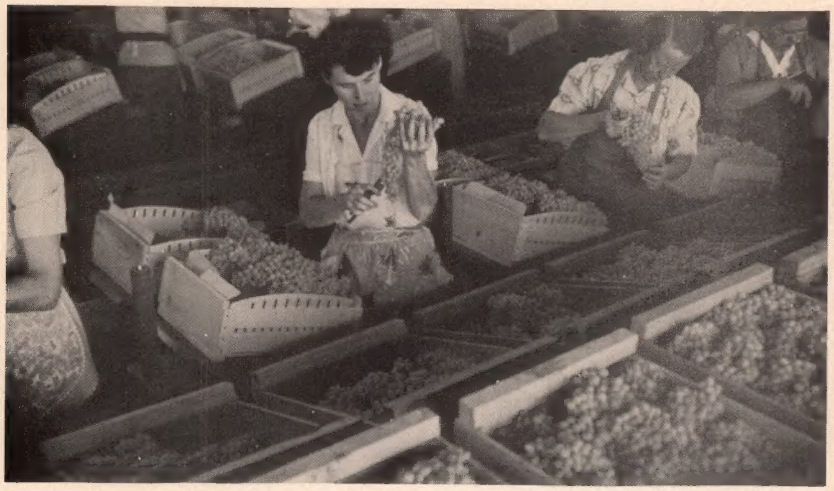

FIGURE 2. Packing stands, mechanized equipment

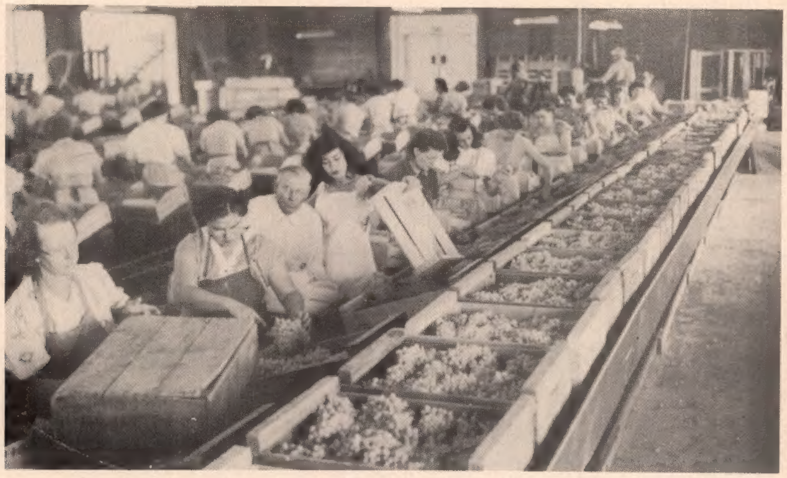

FIGURE 3. Mechanized packing line

There are minor differences in the job depending on whether mechanized or nonmechanized packing equipment is used. With nonmechanized equipment (Figure 1), each full field box is set on the packing stand by a "setup" man who serves several packers. He also sets off the empty lugs and removes boxes of cull fruit where a cull disposal belt is not provided. With mechanized equipment, the field boxes are brought to the packers on a chain conveyor from one end of the packing line (Figures 2 and 3). Packers working with this type of equipment must perform two operations not required of packers on nonmechanized equipment. A foot pedal must be pressed to obtain a new full field box, and the empty box must be disposed of by tipping it and letting it drop on to a conveyor which carries it away from the packing area.3/

Studies of the packing job indicate that the additional work elements associated with mechanized equipment together require an average of less than ten seconds per box. As this time is extremely small relative to the total time required to pack a box, packers will be assumed to be equally productive on either mechanized or nonmechanized equipment.

Grapes are commonly packed in three types of containers--28-pound (net) standard display lugs, 28-pound, four-basket crates, and 32- or 34-pound chests. Usually, each packer is provided with a spring scale on which the packing box rests while being filled and which registers when the box contains the correct weight of fruit. Where individual scales are not used, the boxes are check weighed before lidding. In the discussion that follows, all findings will be expressed relative to the standard display lug as this is the most widely used container.

THE WAGE PLANS

Five different wage payment plans were observed in use among the plants studied. They are of two general types--incentive and constant hourly wage plans. Incentive wage plans permit the hourly earnings of the worker to increase as his rate of output increases. The packer thus has an incentive to work harder and to pack more boxes per hour. The degree of the incentive varies with the level of the earnings and with the rate at which earnings increase as rate of output increases. Constant wage plans, on the other hand, provide no direct incentive since hourly earnings remain constant regardless of rates of

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3/ With some equipment the field boxes may have to be pulled into place by hand rather than sliding in automatically. The difference in time required is very small.

output. The relation between rate of output and earnings per packer hour with the different wage plans is illustrated in Figure 4. Details of the five wage plans are as follows.

A. Flat piece rate. With this method of payment, the workers receive a constant payment for each box packed. During the 1953 season, the rate ranged from 7 to 10 cents per standard display lug for summer grapes,4/ 7 to 8 cents for Emperor grapes, and 9 to 10 cents for Tokay.5/

B. Sliding scale hourly plus piece rate. This method of payment was observed only in one Tokay packing house. The base rate was an hourly wage that varied with the packer's output--ranging from 60 cents per hour for workers packing 4 boxes per hour to $1.00 per hour for workers packing 15 to 17 boxes. In addition, the packer received a flat piece rate of 5 cents per box. No worker could be paid less than the 75 cents per hour required by law.

C. Flat hourly wage plus piece rate. Under this system, each worker was paid a flat 85 cents per hour with an additional 2 cents for each box packed.

D. Sliding scale hourly, then, piece rate. With this plan, the pay per hour increases by 5-cent increments with increases in rates of output, ranging from 75 cents per hour for low rates to 90 cents for high rates of output. A flat piece rate of 9 cents per box is paid for all boxes packed over a prescribed amount. The rate of packing required to qualify for a particular pay scale is slightly less for summer than for Emperor grapes. This plan was not used in plants packing Tokay grapes.

E. Flat hourly wage. The observed pay scale for plants using this wage plan ranged from 90 to 95 cents per hour. In some cases, a minimum rate of output was required in order to qualify for the job, but no incentive pay was given. Two distinct policies were noted in plants paying by this method. In one group of plants, the packers were encouraged or allowed to pack at whatever rates of output they desired, given the requirements as to quality of pack and the absence of direct financial incentive. The average output per packer for these plants is defined as the "normal" hourly rate.

In another group of plants, the management felt that a higher quality pack could be obtained by restricting the rates of packer output. The workers were encouraged to pack very slowly, with both a minimum and a maximum amount that

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4/ Primarily Thompson seedless with some Red Malaga and Ribier.

5/ These rates apply only to fruit packed in the house and not to field packing.

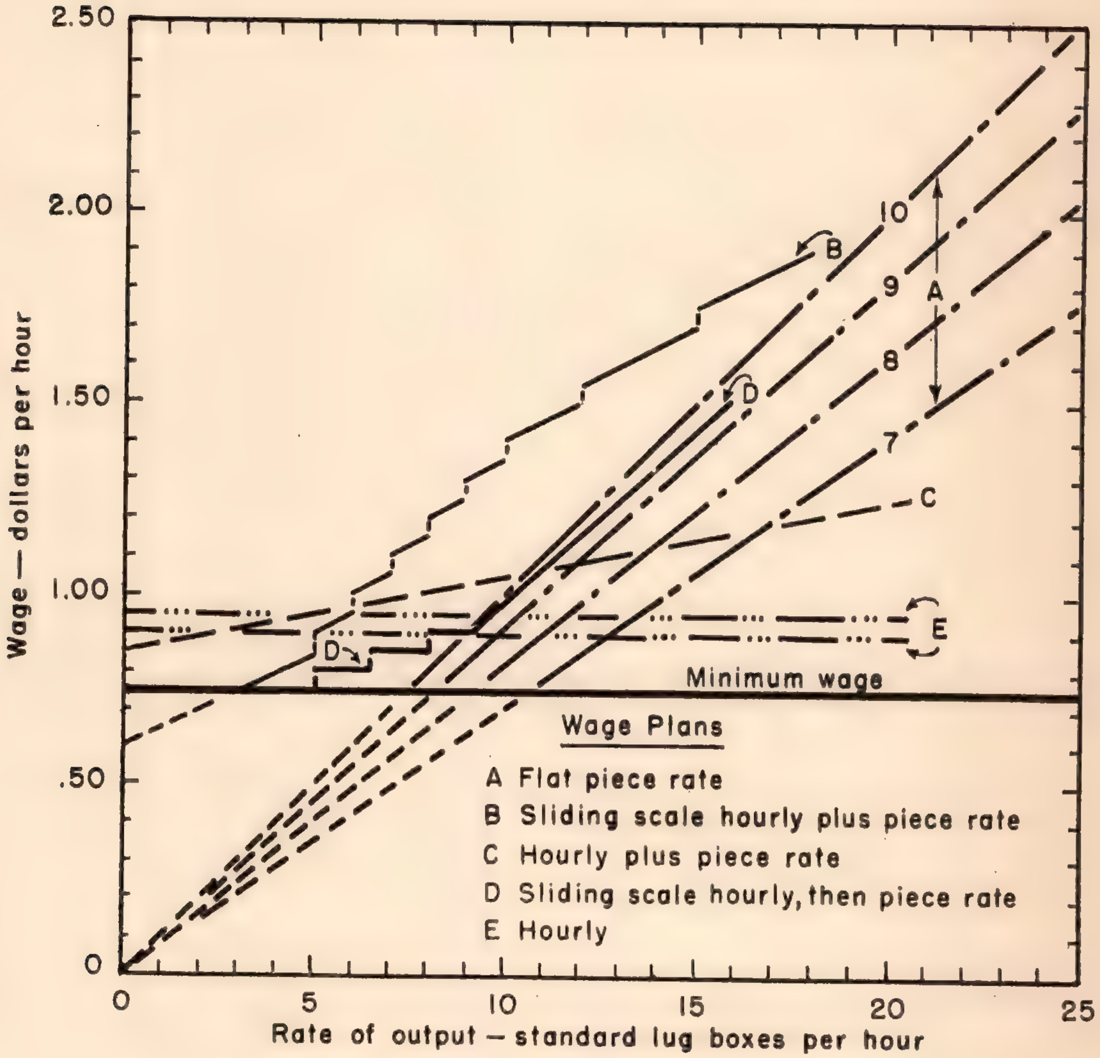

FIGURE 4

The Relation of Hourly Rates of Pay to Rates of Output for Five Wage Plans for Grape Packing

should be packed per hour. The average rate of output for these plants is defined as the "slow policy" hourly rate and will be designated by (E_2). The normal policy rate will be referred to as (E_1).

A comparison of the effects of the different wage plans on packer earnings as rate of output varies is made in Figure 4. In this diagram, hourly earnings with each method of payment are shown in relation to rates of output of standard display lugs. The degree of incentive with the different wage plans is indicated in Figure 4 by the steepness of the slope of the "earnings line."

Wage plan A appears to provide the maximum incentive in that earnings increase more rapidly with increases in rate of output than with any of the other plans. Four rates of pay are shown for the plan, corresponding to the variations noted in different packing houses and among the different varieties of grapes. Plan B shows about the same rate of increase in earnings as the average piece rate with plan A. The level of earnings, however, is somewhat higher than for plan A. It seems logical to expect the higher level of earnings to suppress the reaction of the packers to the increased earnings with increased rates of output. The relative incentive thus may be somewhat less than provided by plan A. This is borneout by statistical evidence to be presented later.

Wage plans C and D provide the next greatest amounts of incentive. As plan C was used only in Tokay packing plants and plan D in Emperor and summer grape plants, there is no statistical evidence to suggest which plan gives the most incentive. On the average, however, it would appear that plan D results in a greater increase in earnings for each increase in rate of output.

Wage plan E provides no direct per-box incentive. No matter what the rate of output, earnings remain constant at 90 or 95 cents per hour. Note that with none of the wage plans are earnings permitted to fall below the legal minimum of 75 cents per hour.

THE EFFECT OF WAGE PLAN, PROPORTION OF CULL FRUIT, AND VARIETY ON PRODUCTIVITY

Individual production records obtained in 24 packing houses for about 1,500 packers have been used to compare the average rates of packer output associated with each of the wage plans described above. The records, classified as to variety of grapes packed, cover several weeks or all of the 1951 season for each plant. These data indicate that in packing Emperor grapes the season average rate of output in different plants ranged from 5.2 to 24.0 boxes per

packer hour; with Tokay grapes, this range was from 8.3 to 13.4 boxes per packer hour; and with summer grapes, the range was from 2.6 to 12.0 boxes per packer hour.

While differences in the incentive provided by the packer wage plan account for a large part of the variation in rate of packer output in different plants, the proportion of cull fruit also is an important factor. This varied considerably between different plants. With Emperor grapes, the average proportion of cull fruit ranged from 12.3 to 36.9 per cent of the total fruit received; with Tokay grapes, the range was from 17.0 to 29.4 per cent; and with summer grapes, it was from 16.1 to 48.5 per cent.[6] To separate the effects of this factor, the per cent of cull fruit has been introduced in Figure 5 as an additional variable in the analysis.[7]

The lines representing the several wage plans in Figure 5 indicate that a rise in the percentage of culls or a decrease in the degree of incentive payment results in reduced rates of packer output. This can be illustrated with the chart for Emperor grapes. With 20 per cent culls, for example, the rate of packing decreases from nearly 21 boxes per packer hour under wage plan A to less than 7 boxes per packer hour with wage plan E_2. If only wage plan A is considered but the per cent of culls varies, the rate of packing decreases from about 23 boxes per packer hour with 10 per cent culls to only 10.5 boxes per packer hour with 60 per cent culls. Comparable reductions are shown with the other wage plans. Similar effects with respect to wage plan and per cent of culls are indicated by the charts for Tokay and summer grapes.

In developing the relationships presented in Figure 5, certain logical assumptions were considered necessary (see Appendix A). Other logical assumptions might have been used which would yield somewhat different results. Hence, estimates

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[6] With some firms a notably high proportion of cull fruit resulted from the fact that vineyard areas containing the better quality fruit were field packed, thus leaving fruit of lower quality for the house pack.

[7] The details of the procedures used to estimate the relation of rate of packer output to the proportion of culls with different wage plans are discussed in Appendix A. In making this analysis, it was assumed that the operating conditions or environments in the various plants, as they affect productivity, are essentially the same, except for the differences in wage plan and proportions of cull fruit. Day-to-day variations in these conditions may be expected due to equipment failures, temperature change, interruptions in deliveries of fruit from the field, and other miscellaneous delays. These factors tend to average out over time, and the analysis is in terms of average conditions. Several plants and a large number of packers are represented with most wage plans, which should further "average out" the effects of specific plant conditions.

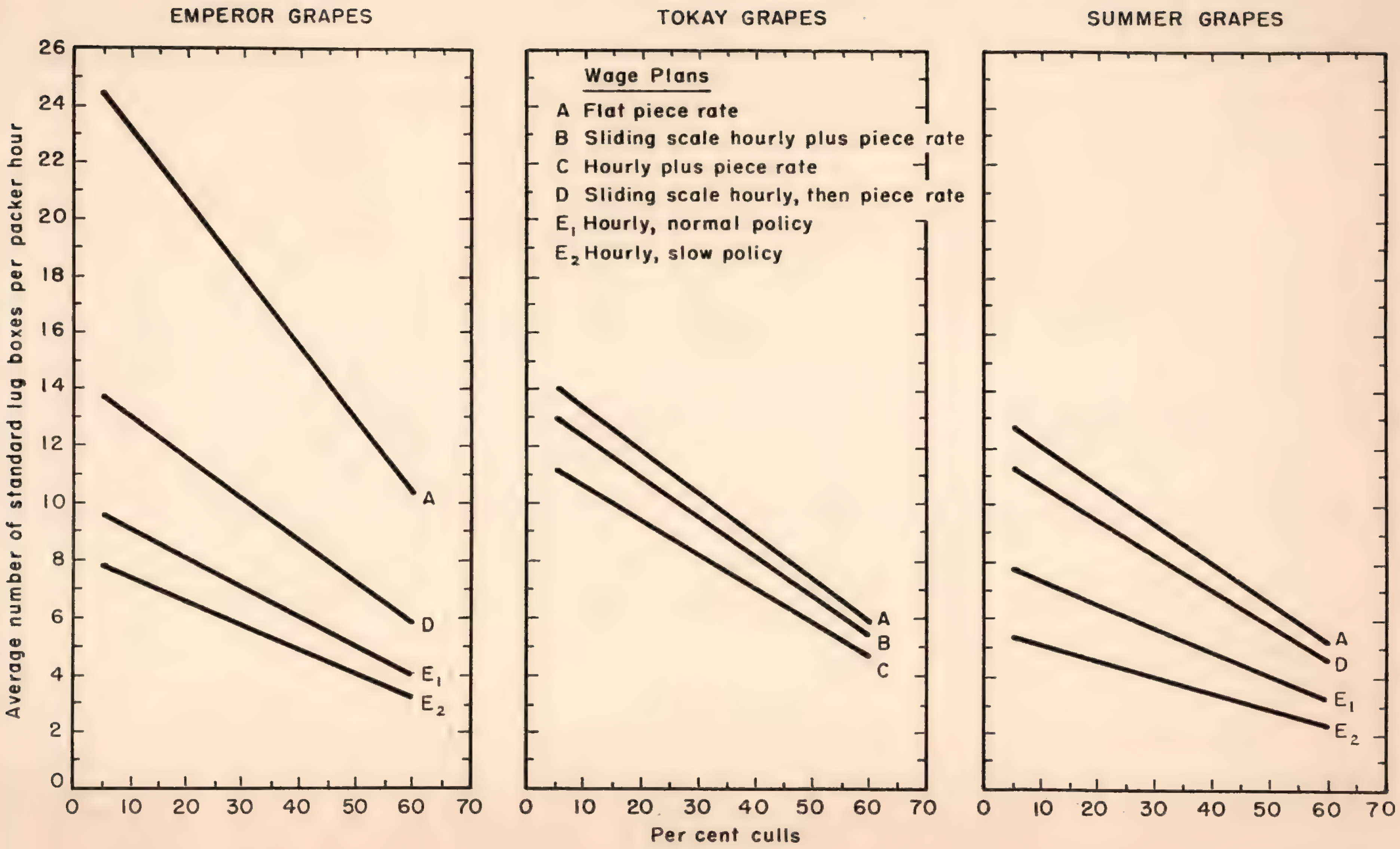

FIGURE 5

The Effect of Wage Plan and Per Cent Culls on Average Rates of Packing California Grapes

of rates of packer output taken from Figure 5 should not be regarded as exact. Figure 5, however, is believed to provide reasonably good indications of average rates of packing in relation to variety, wage plan, and per cent of cull fruit, especially over the range (rarely exceeded in actual packing operations) of 10 to 50 per cent culls.

Further analysis of the effect of per cent of culls on rate of packing indicates that, as the proportion of culls varies, the percentage change in rate of output is about the same with all of the wage plans observed. This makes it possible to compute relative rates of packing with the different wage plans, disregarding the effect of culls. Such comparisons are made in Table 1, in which rate of packing with the various wage plans is expressed as a percentage of the rate with plan A. The table indicates, for example, that rates of output under the normal policy constant wage plan (E_1) are only 39 per cent as high as the rate under plan A for Emperor grapes and 62 per cent of plan A for summer grapes. As suggested earlier, plan A provides a higher incentive than plan B although earnings were shown in Figure 4 to be higher with plan B than with plan A. The higher level of earnings under plan B may, in fact, be the chief cause of the lower incentive with this method of payment.

TABLE 1

Relative Rates of Output For
Five Methods of Paying Grape Packers

Wage plan	Variety		
	Emperor	Tokay	Summer
	per cent of output under wage plan A		
A	100	100	100
B	--	92	--
C	--	80	--
D	56	--	90
E_1	39	--	62
E_2	32	--	43

THE EFFECT OF WAGE PLAN, PROPORTION OF CULL FRUIT, AND VARIETY ON COST

The variations in packer productivity with the different wage plans indicated in Figure 4 have both direct and indirect effects on the costs of packing. Packing costs are affected directly through the cost of packing labor and indirectly through the influence of rate of packer output on the investment required for building space and packing equipment and on the labor and equipment costs of associated operations.

Direct Packing Costs

The effects of each of the several wage plans on average costs per box for packing labor are illustrated in Figure 6. The costs are based on the wage rates indicated in the descriptions of the wage plans and illustrated in Figure 4. For plan A, typical rates were 7½ cents per box for Emperors, 10 cents for Tokays, and 10 cents for summer grapes. The costs shown for the constant wage plan (E) are based on a wage rate of 95 cents per hour, although 90 cents per hour was paid in some plants. The schedule of rates under plans B and D (Emperors) are rather complicated and can be grasped most readily by referring to Figure 4. The pay rates shown for plan D are for packing Emperor grapes. The same rates apply to summer grapes except that the pay rates increase at 4.5, 5.5, 6.5, and 8.0 boxes per hour. The rate is 9 cents per box for all over 8.0 boxes per hour.

The curves in Figure 6 indicate that packing labor costs per packed box are generally higher with hourly than with the various incentive wage plans. With 30 per cent culls, for example, the difference between plans A and E_2 amounts to about 9 cents per box for Emperor grapes and nearly 14 cents for summer grapes. Comparing plan A with E_1 indicates that with 30 per cent culls plan A saves about 6 cents per box for Emperor grapes and nearly 7 cents for summer grapes. Cost differences between plan A or plan E and plans B, C, and D--combinations of constant and incentive wages--fall between these extremes. Differences in cost among the various wage plans become smaller as the proportion of culls decreases, but the differences are still of substantial magnitude in most ranges.

Indirect Cost Effects

In the preceding discussion, the rate of packer output is shown to vary widely, depending on the variety of grapes packed, the wage plan, and the per cent of culls. This has an important bearing on direct packing labor costs as is indicated in Figure 6. There also are substantial "indirect" effects. As rate of packing decreases, the number of packing stations required for a given

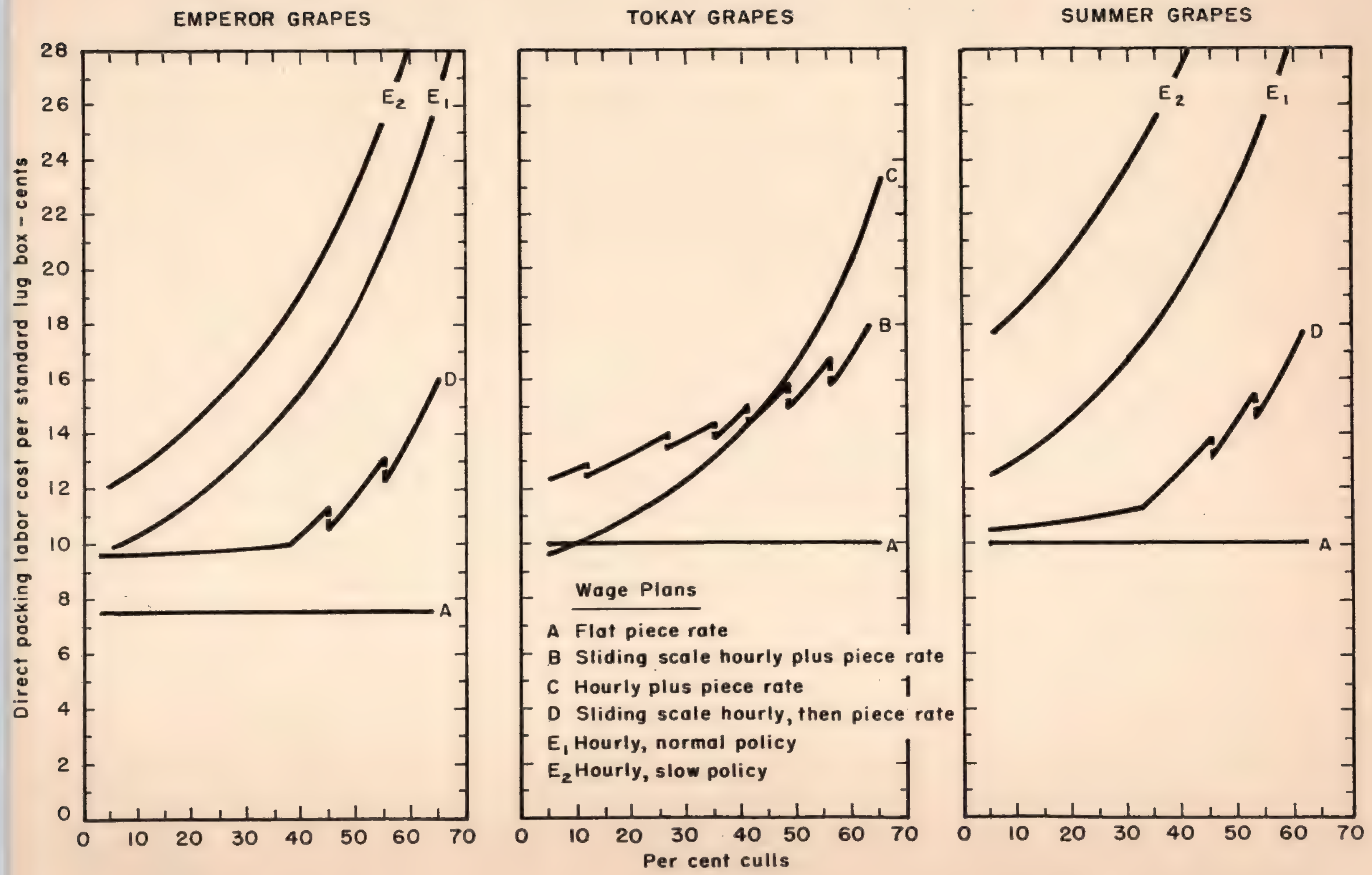

FIGURE 6

The Effect of Wage Plan and Per Cent Culls on Direct Packing Labor Cost Per Standard Display Lug

rate of plant output increases. This requires larger quantities of equipment for supplying fruit to the packers and increases building space requirements and trucking distances. Changes in the proportion of cull fruit, with a given output of packed boxes, directly affect the number of field boxes and quantities of cull fruit to be handled and thereby affect the costs of trucking incoming fruit, setting up fruit for the packers, and handling cull fruit.

The costs of other operations, such as boxmaking, supplying empty boxes to the packers, lidding packed boxes, and carloading, are affected to some extent by the rate of packer output. Crew organization and equipment required for these operations, however, are directly related to the rate of total output of packed boxes and can be closely adjusted to this rate. For this reason, the following analysis of how costs are affected by variations in rate of packer output and per cent of culls is limited primarily to the operations involved in supplying fruit to the packers. The factors considered include the costs of trucking labor and equipment for handling incoming fruit and culls, the labor costs of "setting up" fruit for the packers, and the costs of equipment, building space, and power used in supplying fruit to the packers and in disposing of culls. The costs of equipment for transporting packed boxes to the lidder and for conveying empty boxes to the packers vary directly with the rate of packer output and this one additional element is included. For convenience, the operations included in this analysis of "indirect" effects will be referred to as "packer supply operations."

Two categories of costs must be considered. These are the variable costs of labor, equipment repair, and power and the fixed costs of depreciation, interest, taxes, and insurance for equipment and building. Regarding fixed costs for equipment, it is necessary to consider the total number of boxes packed per season since fixed costs per box decrease as total season volume in a given plant increases. It also is recognized that costs per box for some operations may vary with changes in the size of plant and that this may affect variations in cost due to changes in rate of packer output. For the range in plant size commonly encountered, however, variations in cost per box due to size of plant are not large, and size of plant probably has still less effect on the amount of variation in cost due changes in rate of packer output. For this reason, the analysis that follows is limited to a plant size of 600 boxes per hour. The results should be generally applicable to California grape packing plants.[8]

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[8] In the plants studied, the rate of output averaged 620 boxes per plant hour for summer grapes, 530 boxes per plant hour with Emperors, and 260 boxes per plant hour for Tokays.

Estimates of the costs of the packer supply operations which show how the costs per plant hour for labor, equipment repair, and power and the annual fixed charges for equipment and building space change with variations in the rate of packer output are given in Table 2. In these estimates, culls are held constant at 30 per cent, while rates of packer output range from 5 to 20 boxes per packer hour. Costs are shown for two types of equipment. With the nonmechanized packing equipment, incoming fruit is hand trucked to a position paralleling the packing line and field boxes are set up individually for each packer (Figure 1). Culls are collected in boxes and later emptied by hand into a highway truck. In the mechanized plants, incoming fruit is hand trucked to the setup position of a mechanized conveyor system. Full boxes are carried to the packers by conveyor, and empty lugs are returned by conveyor to the setup position (Figures 2 and 3). Culls are conveyed by belt to an overhead bin from which they are delivered by gravity to a highway truck. Table 2 also gives estimates of unit costs per box for the variable costs, annual fixed costs for equipment and building space, and total costs per box.[9]

From Table 2 it is evident that variable costs for labor are higher with the nonmechanized than with the mechanized equipment. For example, with a packer output of five boxes per packer hour, the labor costs are $13.22 per hour with the nonmechanized equipment and $10.30 per hour with the mechanized

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[9] Because of the many variations to be considered, an analysis of this problem by comparing the average accounting costs of a number of different firms is not practicable. The costs given in Table 2 are based on engineering studies of labor, equipment, and building space requirements and costs. The costs indicated are believed to be representative of those resulting under conditions of relatively efficient operation. Labor costs are computed at the levels prevailing in the districts packing summer and Emperor grapes. To adjust labor costs to the levels prevailing in the Tokay district, the labor costs given should be increased by 20 per cent. The estimates of equipment and power costs are the same in all districts.

The estimates assume uniform operation at the rates of output specified. Because of the difficulty of fully adjusting the operations in a given plant to unavoidable day-to-day variations in quality of fruit and rate of output, actual plant costs may be somewhat higher than those indicated. The relative costs with different types of equipment, different rates of plant and packer output, and different wage plans should, however, be about the same in either case.

Details of the cost analysis given in Table 2 will be given in a subsequent report.

In each type of plant, numerous minor variations in method are possible. The effect of such variations on relative costs with mechanized and nonmechanized packing equipment is not great, however, and is not considered in this report.

TABLE 2

Costs of Packer Supply Operations in Relation to Type of Equipment and Rate of Packer Output in a Typical Grape Packing Plant of 600-Box-Per-Hour Capacity, California, 1953[a]

Packer output, boxes per packer hour	Number of packers required	Variable costs			Total annual fixed[d] cost	Costs per box						
		Equipment repair and power[b]	Labor cost[c]	Total cost		Variable costs	Annual fixed cost			Total cost		
							250 hours per season	500 hours per season	750 hours per season	250 hours per season	500 hours per season	750 hours per season
		dollars per plant hour			dollars	dollars per box						
Nonmechanized packing equipment												
5	120	0.28	13.22	13.50	4,205	.023	.028	.014	.009	.051	.037	.032
10	60	0.18	12.76	12.94	2,740	.022	.018	.009	.006	.040	.031	.028
20	30	0.13	12.75	12.88	2,000	.022	.013	.007	.004	.035	.029	.026
Mechanized packing equipment												
5	120	2.57	10.30	12.87	9,533	.021	.064	.032	.021	.085	.053	.042
10	60	1.29	9.28	10.57	5,813	.018	.039	.019	.013	.057	.037	.031
20	30	0.89	8.44	9.33	4,122	.016	.027	.014	.009	.043	.030	.025

[a] Details concerning these cost calculations will appear in a subsequent publication.

[b] Variable repair costs for equipment are estimated at the rate of 0.5 per cent of the replacement cost of equipment per 100 hours of use. Electric power costs are estimated at the rate of 0.03 cent per motor horsepower.

[c] Labor costs are based on the 1953 wage level in districts packing Emperor and summer grapes. For 1953 labor costs in the Tokay district, add 20 per cent to those given in the table.

[d] Estimates of annual fixed costs for equipment are based on the following percentages of 1953 replacement costs: taxes, 1.0; insurance, 1.0; "fixed" repair expense, 1.5; interest, 3.0 (an average rate of 5.0 per cent on the undepreciated balance of the investment); depreciation, conveyor equipment (boxes), 6.7; conveyor equipment (culls), 10.0; cull boxes and bins, 10.0; and hand trucks and equipment for packer supply, 6.7. A similar schedule is used for building costs, excepting "fixed repair," which is estimated at the rate of 2.0 per cent and depreciation for which the rate is 3.0 per cent.

equipment, a difference of $2.92 per hour. The difference in total variable costs is considerably less, however, as the saving in labor is partially offset by increased costs of equipment repairs and power. Annual fixed costs for equipment and building space are considerably higher in the mechanized plant. For example, with a packer output of five boxes per packer hour, these annual fixed charges are $9,533 in the mechanized plant in contrast with $4,205 in the nonmechanized plant.

With either type of equipment, variable costs and annual fixed charges for equipment and building space, with a given rate of plant output, decrease as the rate of packer output increases. Thus, with an increase in rate of packer output from 5 to 20 boxes per packer hour, variable costs in packing 600 boxes per plant hour with the nonmechanized equipment decrease from $13.50 to $12.88 per plant hour, and annual fixed charges for equipment and building space decrease from $4,205 to $2,000. With the mechanized equipment, the corresponding range in variable costs is from $12.87 to $9.33 per plant hour, and the range in annual fixed charges for equipment and building space is from $9,533 to $4,122. These variations in variable costs per plant hour and in annual fixed charges for equipment and building space are reflected in the unit costs per box given in Table 2.

In the preceding analysis of how the packer supply costs vary with rate of packer output, the proportion of cull fruit is held constant at 30 per cent. In the actual operation of different plants, however, the average proportion of cull fruit varies widely. It is an important cost factor through its effect on rate of packer output and on the quantity of incoming fruit and culls that must be handled for a given output of packed boxes.

How variations in the proportion of cull fruit affect the variable costs of packer supply operations--ignoring for the moment effects on direct packing labor and on fixed costs for equipment and building space--is illustrated in Figure 7. In this chart, the variable costs of the packer supply operations in a plant of 600-box-per-hour capacity are shown in relation to type of equipment, proportion of cull fruit, and rate of packer output. The chart shows that, with mechanized equipment and an output per packer of 20 boxes per hour, an increase in culls from an average rate of 10 to 50 per cent results in a rise in the variable costs of the packer supply operations of about 1.2 cents per box. With a rate of output of only three boxes per packer hour, this increase is 1.7 cents per box. With nonmechanized equipment, an increase in the proportion of culls from 10 to 50 per cent adds 1.9 cents per box to the packer supply variable costs

when the rate of packer output is 20 boxes per packer hour and 2.0 cents per box when the rate of packer output is 3 boxes per packer hour.

Total Costs of Direct Packing Labor and Packer Supply Operations

With the data presented thus far, it is possible to estimate the costs of direct packing labor and packer supply operations in relation to specified operating conditions. These conditions include variety of grape, per cent of culls, and wage plan. For example, in packing Emperor grapes with 30 per cent culls under wage plan E_1, the typical rate of packer output is given in Figure 5 as 7 boxes per packer hour; direct packing labor costs with this rate of packing are given in Figure 6 as 13.3 cents per box; and variable costs of the packer supply operations are given in Figure 7 in a mechanized plant (with 30 per cent culls and a packing rate of 7 boxes per packer hour) as 1.9 cents per box. The total variable cost of direct packing labor and packer supply operations then is 15.2 cents per box.

Similar computations have been carried out for the different varieties of grapes and different wage plans. The results have been combined with estimates of fixed costs for equipment given in Table 2 to give the estimated costs per box for direct packing labor and packer supply operations presented in Figure 8. The costs given in this chart are based on the assumption of 500 hours of plant operation per season and are related to type of equipment, variety of grape, per cent of culls, and wage plan. Estimated per-box costs will be higher, or lower, than indicated in Figure 8 as the length of season is varied. The amount of variation from unit costs based on a 500-hour packing season can be expressed as a percentage of the costs indicated in Figure 8. For example, with mechanized equipment, costs per box with 250 hours of operation per season are approximately 14 per cent higher and with 750 hours of operation are about 5 per cent lower than the unit costs given in Figure 8. With nonmechanized equipment, costs per box increase 7 per cent with only 250 hours of plant operation per season and decrease 2.5 per cent with 750 hours of operation per season from the levels indicated in Figure 8.

With so many factors to be considered, the results presented in Figure 8 are necessarily complex so that a full discussion of them will not be attempted. Several points should be noted, however, which will illustrate their content.

1. The costs per box given in Figure 8 are based on the assumption of 500 hours of plant operation per season. However, the percentage adjustments given above could be applied to the costs given in Figure 8 for a particular type of

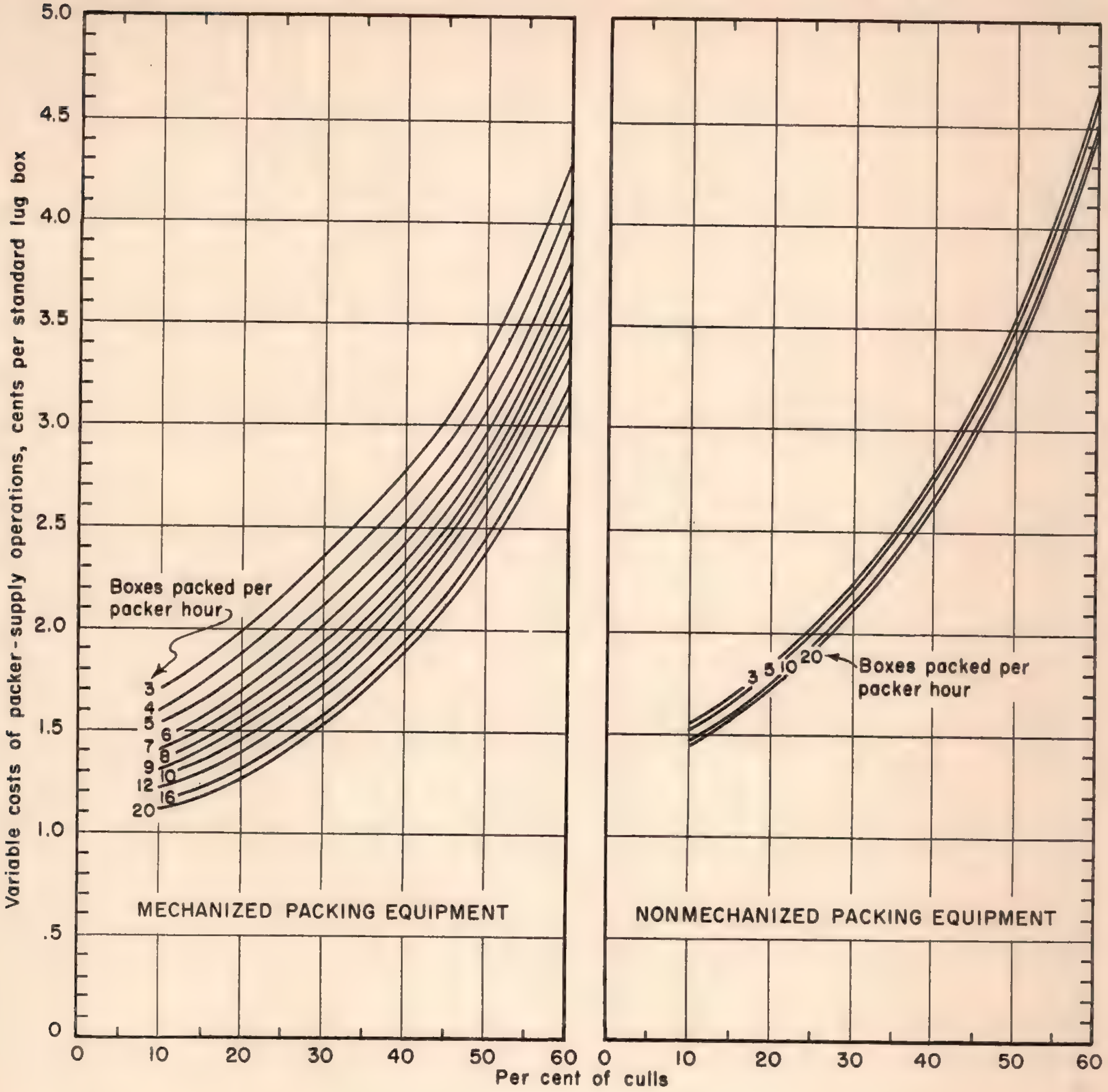

FIGURE 7

The Effect of Type of Equipment, Proportion of Cull Fruit and Rate of Packer Output on the Variable Costs of the Packer-Supply Operations

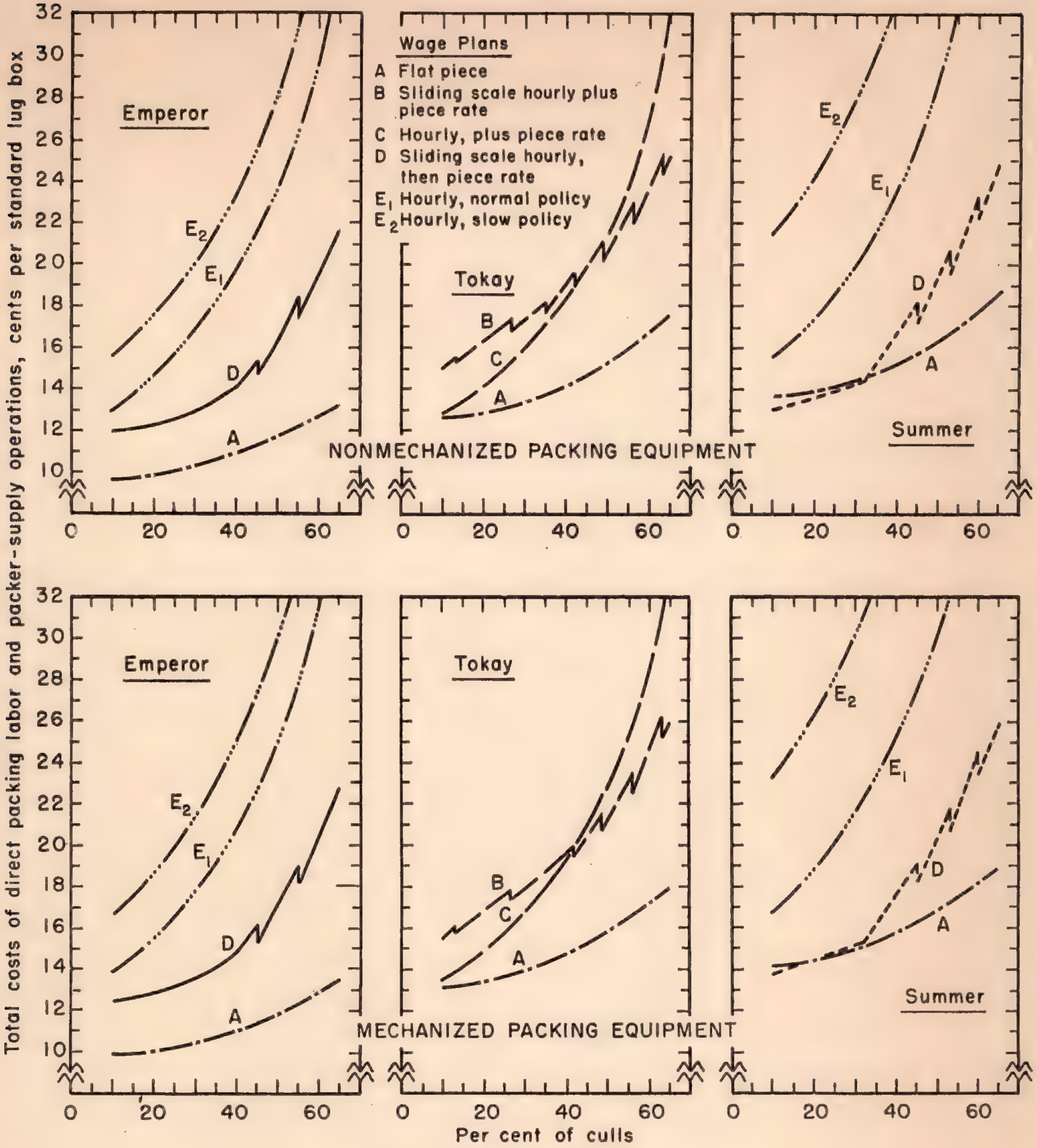

FIGURE 8

The Effect of Type of Equipment, Variety of Grape, Per Cent of Cull Fruit and Wage Plan on the Total Costs of Direct Packing Labor and Packer-Supply Operations in a Plant Operating 500 Hours Per Season[a]

[a] To estimate costs with 250 and 750 hours of plant operation per season, the levels of cost given above may be adjusted as follows: for a 250-hour season, with mechanized equipment, add 14 per cent and with nonmechanized equipment, add 7 per cent; for a 750-hour season, with mechanized equipment, subtract 5 per cent and with nonmechanized equipment, subtract 2.5 per cent.

equipment, variety of grape, per cent of culls, and wage plan to establish a range in costs that would reflect the effect of length of season on unit costs per box. When this is done, it appears that costs per box with nonmechanized equipment are a little lower than with mechanized equipment when the season is short and the proportion of culls low. As the length of season and proportion of culls increase to a fairly high level, these relationships are reversed. The cost advantage of the mechanized equipment is greatest with the incentive wage plans. This is to be expected since the higher equipment cost per packing station with mechanized equipment has a decreasing influence on costs per box as the rate of packing per station increases. With a given proportion of culls, cost per box decreases more rapidly with the mechanized than with the nonmechanized equipment as the length of season increases.

2. Costs per box increase as the per cent of culls increases. The amount and nature of this variation depend on the wage plan as is evident in the following summary drawn from Figures 6 and 8 and pertaining to Emperor grapes packed in a plant using nonmechanized packing equipment.

	Per cent of culls	
	10	50
	cents per box	
Wage plan A--piece rate		
Total cost per box (Figure 8)	9.6	11.7
Less direct packing labor per box (Figure 6)	7.5	7.5
Costs of equipment and packer supply labor	2.1	4.2
Wage plan E_2--slow hourly rate		
Total cost per box (Figure 8)	15.5	28.1
Less direct packing labor per box (Figure 6)	12.8	22.9
Costs of equipment and packer supply labor	2.7	5.2

As indicated in the above summary, the per-box cost of direct packing labor with wage plan A is constant. Higher costs as per cent of culls increases is due to increases in the "indirect" costs of packer supply. With the slow hourly rate plan E_2, the per-box costs of both direct packing labor and the "indirect" costs of packer supply rise with increase in per cent of culls.

3. There is a substantial range in costs with different wage plans, and this range increases as the proportion of culls increases. In the above example (packing Emperor grapes in a plant operating 500 hours per season), the total cost of direct packing labor and of packer supply operations with 10 per cent

culls varies from 15.5 cents per box with wage plan E_2 to 9.6 cents per box with wage plan A. With 50 per cent culls, the corresponding range is from 28.1 cents to 11.7 cents per box.

Similar variations in costs in relation to wage plan and per cent of culls occur with Tokay and summer grapes.

THE EFFECT OF WAGE PLAN, PROPORTION OF CULL FRUIT, AND VARIETY ON PACKER EARNINGS

The wage plan for packers has a substantial effect on packer earnings. This obviously is of importance to the worker. It may also be of importance to the plant management since the income position of the packers bears on the problems of worker procurement, quality of personnel, and quality of performance.

Average hourly earnings for each of the observed wage plans are shown in Figure 9 in relation to the average per cent of fruit trimmed out as culls. Figure 9 indicates that, when the proportion of defective fruit is small, average hourly earnings for all incentive wage plans are considerably greater than with hourly pay. As the per cent of culls increases, hourly pay earnings remain constant while incentive earnings decline. When summer grape culls exceed 30 per cent, for example, average earnings for flat piece-rate packers are less than for those receiving constant hourly pay. For Emperor grapes, flat piece-rate earnings remain above hourly earnings until culls reach 51 per cent--a much higher proportion than normally found.

The particular levels of earnings and the relative earnings shown for the various wage plans hold, of course, only for the systems and rates of wages observed in this study. Changes in wage rate would affect earnings directly with all wage plans and--with the incentive wage plans--might also affect earnings through changes in rate of output. This makes it unwise to generalize freely from the results given in Figure 9, but the following observations can be made on the basis of the particular wage structure on which Figure 9 is based. In their more general aspects, these observations would also hold with minor deviations from this wage structure.

The relative positions of the curves shown in Figure 9 show substantial differences in level of earnings in relation to wage plan, proportion of culls, and variety. The effect of variety can be illustrated by comparing average earnings in packing Emperor and summer grapes in plants using wage plan A. Thus, if culls average 25 per cent with wage plan A, average earnings would amount to about $1.45 per hour for Emperor grapes and only $1.00 per hour for summer grapes.

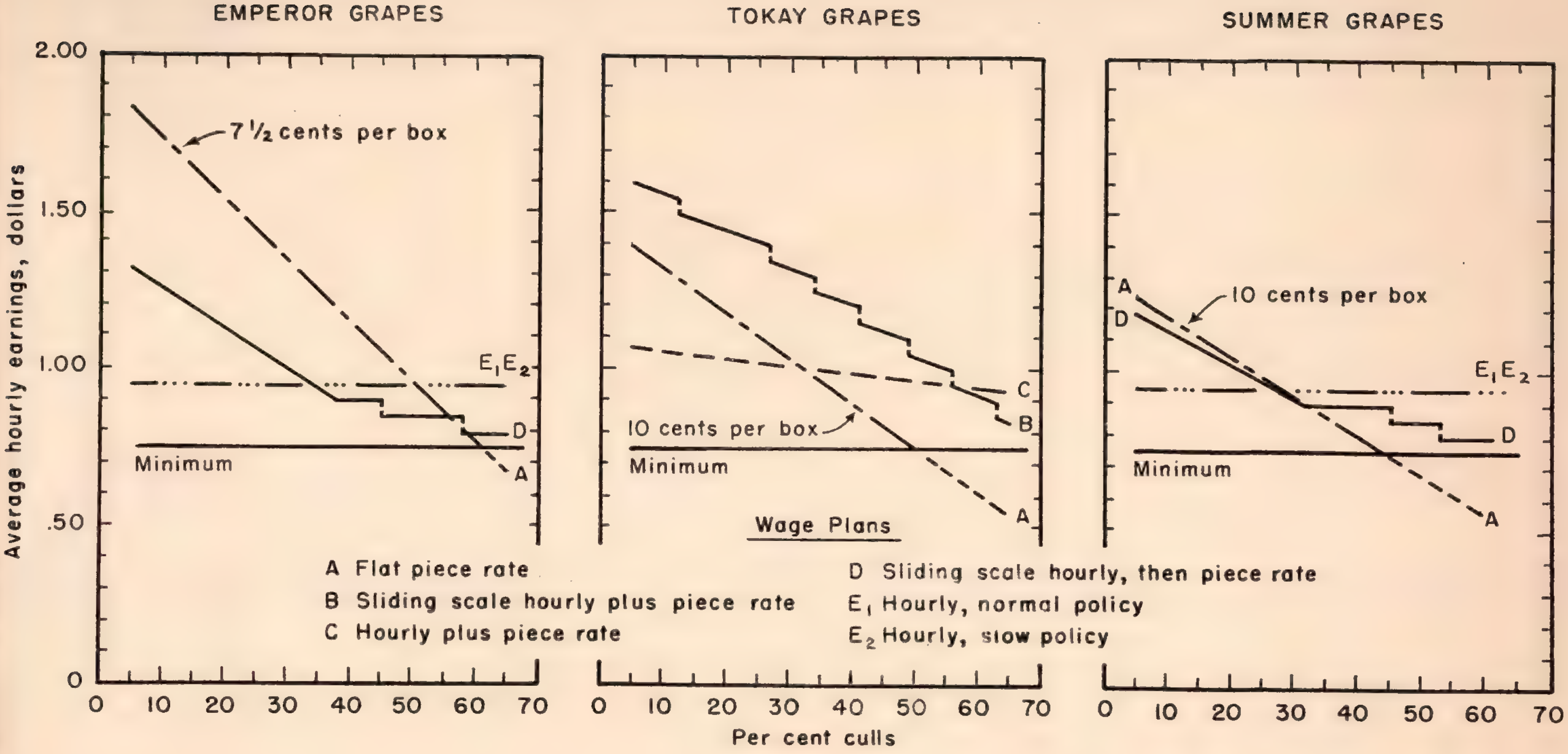

FIGURE 9

The Effect of Per Cent Culls and Variety of Grapes on Average Hourly Earnings of Direct Packing Labor

Earnings with constant hourly pay, on the other hand, would remain the same for both types of grapes and would not be affected by the proportion of culls.[10]

A departure from the tendency for higher hourly earnings to be associated with a high incentive wage plan is evident in comparing incentive plans A and B in the Tokay plants. Plan A provides the highest incentive as measured by rate of output (Figure 5), but plan B yields higher earnings (Figure 9). Thus, holding per cent of cull fruit constant, a packer of Tokay grapes paid under wage plan A packs more fruit and receives less money than a packer paid under wage plan B. As the proportion of cull fruit increases, a similar situation appears in comparing summer grape packing under wage plans A and D; this also is true with all three varieties of grapes when any of the incentive wage plans are compared with the nonincentive hourly rate plans.

Changes in relative earnings among these wage plans with changes in the proportions of culls may have important effects on the efficiency of the plant operation and the quality of the finished package. Under the combination wage plans, the direct burden of increased proportions of culls is shared by both the packers and the plant. That is, packer earnings fall and average costs increase. With flat piece rates, the direct burden of increased culls is borne by the packers, while the packing house carries the full cost under a straight hourly plan.

As the per cent of culls increases, the packers receiving flat piece rates may become less and less willing to take the time to trim out the amount of defective fruit required to meet the desired quality standards. Quality, therefore, may fall and so the price of the final product. Moreover, as culls increase to a point where the level of earnings is quite low, labor supplies may be difficult to obtain or hold.

What can or should be done about these conditions and how do they influence the selection of "most efficient" wage plans? Before attempting to answer these

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[10] Among the plants using wage plan A, culls averaged 23 per cent for Emperor grapes and 26 per cent for summer grapes.

questions, it is necessary to give some additional attention to the influence of the methods of payment on the quality of the finished package.

EFFECTS OF WAGE PLANS ON QUALITY

The quality of a box of grapes is defined by factors such as coloring, maturity, size of berries and bunches, sugar-acid content, uniformity, and the proportion of defective berries. Since fruit received at the packing house may vary widely in quality, one of the important functions of the packer is to assure that the packed fruit meets established standards with respect to the various quality characteristics. This is accomplished by rejecting substandard fruit or by trimming out off-color or defective berries. The packer, therefore, has some control over the quality of the packed fruit. It is clear, however, that many of the quality characteristics depend on cultural practices, weather, maturity at time of harvest, and other factors beyond the control of the packer, so that a scoring of packed fruit on the basis of quality characteristics could only partially reflect the results of work by the packer.

A true measure of the quality of the packed fruit in relation to wage plan would require a comparison of quality ratings before and after packing. If the measurement of quality were made at a terminal market, the effects of differences in mode of shipment and variations in conditions during transportation to the market would also have to be considered. Data for this kind of analysis of fruit quality as affected by the packer wage plan were not available. Nevertheless, three attempts were made to determine whether the method of payment of packers influences the quality of the packed fruit. These consisted of (1) comparison of auction market prices received by plants using the different packer wage plans, (2) comparison of measures of observed quality characteristics of Thompson Seedless grapes in the New York auction market, and (3) comparison of amounts of defective fruit indicated by records of the California Bureau of Shipping Point Inspection to have remained in fruit packed by plants paying by the different wage plans.

Auction Market Prices

In the first of these comparisons, it was assumed that differences in quality will be reflected in differences in price and that consistent differences between prices received by plants operating under different packer wage plans would indicate the possibility of a significant relation between wage plan, quality, and price.

To investigate this question, data were obtained as to prices received by each of the sample plants during the 1951 season in ten major auction markets. It was recognized that valid comparisons could be made only if prices were compared for sales made under similar circumstances. This limited comparisons to prices received for a given variety and grade of fruit, sold on the same day, in the same market, and for which transportation to market was by the same means--that is, by rail freight or express. The effect of these restraints was to limit the usable data to a relatively small number of paired prices, which indicate the difference, if any, in the prices received in a given auction for grapes packed under different wage plans. Three sets of comparisons made on this basis are summarized in Table 3. Prices received by two different plants operating under wage plan E_2 (slow, hourly rate plan) are paired with prices received by plants operating under wage plan A (straight piece-rate plan). Similar comparisons are made between wage plans E_2 and D and between wage plans E_2 and E_1.

Each line in Table 3 relates to paired observations on sales by two different plants and gives: (1) the number of pairs of observations; (2) the average price received by plants using wage plan E_2; (3) the average difference in prices received; and (4) the number of times fruit packed under plan E_2 received a higher price than fruit packed under an alternative wage plan. The comparisons between wage plans E_2 and A contain a total of 38 paired observations, in 26 of which prices received under wage plan E_2 were higher than those received under wage plan A. This price premium in favor of wage plan E_2 averaged 25 cents per box. Contrasting wage plans E_2 and D, there is a total of 16 paired observations in only 5 of which the prices received by plants using wage plan E_2 were higher than with wage plan D. For the total of 16 paired observations, however, prices with wage plan E_2 averaged 24 cents per box less than with wage plan D. In comparing wage plans E_2 and E_1, a total of 37 paired prices was available, in 19 of which the prices received by plants using wage plan E_2 exceeded those received by plants using wage plan E_1. The average price difference was 17 cents per box in favor of wage plan E_2.

Before attempting to draw conclusions from the above data, the statistical significance of the price comparisons should be considered. From such tests, it appears that the apparent tendency for prices received by plants using wage plan E_2 to exceed those received by plants using wage plan A is statistically significant. In contrasting wage plans E_2 and D and E_2 and E_1, however, no statistically

TABLE 3

Summary of Auction Market Price Comparisons Between Plants Using Packer Wage Payment Plans A, D, E_1, and E_2a/

Packing plants					
Wage plan E_2	Alternate wage plan	Average price, plan E_2b/	Average price difference, E_2, less alternateb/	Number of paired observationsc/	Number of times plan E_2 highest
		dollars per box	dollars per box		
		Wage plans E_2 versus A			
6	3	3.00	0.29	4	4
6	16	2.99	0.19	3	2
6	12	3.84	0.40	9	7
6	14	2.14	0.11	2	0
7	14	2.20	-0.15	1	0
7	25	2.22	-0.18	3	0
7	16	2.81	0.14	4	3
7	12	4.36	0.56	6	5
7	3	2.82	0.16	6	5
Total				38	26
Weighted averaged/		3.24	0.25		
		Wage plans E_2 versus D			
6	8	3.57	-0.31	11	3
7	8	3.37	-0.08	5	2
Total				16	5
Weighted averaged/		3.34	-0.24		
		Wage plans E_2 versus E_1			
6	2	2.89	0.26	5	3
6	18	4.14	-0.12	12	2
7	2	2.78	0.14	4	3
7	18	3.52	0.34	16	11
Total				37	19
Weighted averaged/		3.51	0.17		

a/ Prices refer to carlot or near carlot sales. For these observations, prices did not appear to be influenced by lot size.

b/ Based on sales of fruit in the same auction market on the same day and representing fruit shipped in same manner (that is, freight or express).

c/ Wage plans defined as follows: plan A, straight piece rate; plan D, sliding scale hourly, then, piece rate; plan E_1, normal hourly rate; and plan E_2, slow hourly rate.

d/ Averages are weighted by the number of paired observations.

significant relations between these wage plans and prices received are indicated.[11]

It should be emphasized, however, that these price comparisons do not take into account several factors that may influence prices received much more than the packer wage plan. As noted earlier, quality is influenced by many factors that are beyond the control of the packers. In addition, brand names frequently may affect the auction price independently of the quality of fruit in a particular lot.[12] Moreover, the relatively small number of paired observations that could be used and the pooling of paired observations from different markets and between several different "pairs" of plants suggest caution in interpreting the statistical tests. These considerations lead to the conclusion that the auction market price data give no clear indication as to the relation between packer wage plan and fruit quality.

Auction Market Quality Observations

An effort to correlate auction market quality ratings with packer wage plan was made on the basis of quality ratings obtained in a study by Lee and Richardson of variations in the prices of fresh Thompson Seedless grapes sold in the New York auction market in 1951. The rating procedure involved sampling numerous lots of fruit sold in the auction and scoring the samples for certain characteristics, such as color, berry condition, acid sweetness, pack condition, stem condition, berry size, pack treatment, presence of wetness or waterberries, and an over-all subjective rating of fruit quality.[13]

Ratings on five quality characteristics--fruit quality, berry condition, pack condition, stem condition, and berry size--are summarized by wage plan and

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[11] The sign test was used to test the significance of observed price differences. This test, applied to the pooled observations for wage plan E_2 versus wage plan A indicates a significant difference at the 5-per cent level of significance. A similar test of differences applied to wage plan E_2 versus wage plan D indicates the price differences to be significant only at the 25-per cent level of significance, while the test applied to wage plan E_2 versus E_1 indicates no significant difference at the 25-per cent level of significance.

[12] For a more complete analysis of the effect of quality and other factors on fresh grape prices, see Ivan M. Lee and H. B. Richardson, Factors Related to Auction Price Premiums--Fresh Thompson Seedless and Tokay Grapes (Berkeley: University of California, College of Agriculture, Agricultural Experiment Station, January, 1954), 45p. (Giannini Foundation Mimeographed Report No. 160.)

[13] Ibid.

quality characteristic in Table 4.[14] The data pertain to fruit shipped by nine different plants. Only freight shipments are represented since very few of the firms studied made a significant number of express shipments.

As indicated in the table, scores of 1 to 5 were possible in rating individual samples on fruit quality; pack condition was scored 1 or 2; berry condition and stem condition were scored 1, 2, or 3; and scores for berry size ranged from 1 to 6. In each case, the highest quality rating was scored 1, with fruit of lower quality receiving higher scores.[15] For example, a total of 321 ratings of "fruit quality" was recorded for plants using wage plan E_2. Of this total, 238 ratings were scored 2, while on fruit of lower quality, 81 samples were scored 3, and 2 samples were scored 4. None of the fruit rated in this category scored in the best grade (score 1) or in the poorest grade (score 5). Similarly, a distribution of scores is given for wage plans E_1, D, and A, and for the quality characteristics, pack condition, berry condition, stem condition, and berry size.

Examination of the table shows that, on ratings of over-all fruit quality and stem condition, there was a strong tendency for plants using wage plan E_2 to receive lower scores (reflecting higher quality ratings) than plants using the other wage plans. This tendency also is present, although considerably less marked, for the characteristics "pack condition," "berry condition," and "berry size." Tests of the data indicate that the differences in distribution of scores among all the wage plans are statistically significant.[16]

If plants using wage plan E_2 are omitted, the indications as to the effects of wage plan on quality score are mixed. Based on the distribution of scores for

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[14] Scores on the characteristics "taste" and "color" are difficult to interpret, and the data on these ratings have been omitted from Table 4.

[15] In the inspections, stem condition ratings were scored under the categories "fresh," "pliable," and "dry." Within each of these categories, the ratings were subclassified as to stem color--that is, as to whether the stems were green, yellow, or brown. For convenience in analysis, the subclassification was abandoned and the ratings were grouped as: fresh, 1; pliable, 2; and dry, 3.

[16] Under the hypothesis that there is no difference in distribution of scores among wage plans, a chi-square test applied to the quality scores yields the following chi-square values: fruit quality, $\chi^2 = 236.5$; pack condition, $\chi^2 = 32.0$; berry condition, $\chi^2 = 17.8$; stem condition, $\chi^2 = 38.4$; and berry size, $\chi^2 = 104.7$. Critical chi-square values at the 5-per cent level of significance are 26.2, 11.3, 16.8, 12.6, and 25.0, respectively. These results indicate rejection of the hypothesis that there is no significant differences in the distribution of scores among all the wage plans.

TABLE 4

Comparison of Selected Market Quality Ratings on Fresh Thompson Seedless Grapes Among Nine Sample Plants Paying Packers by Wage Plans A, D, E_1, and E_2[a]

		Number of ratings, distributed by quality score received on individual inspections				
		E_2	E_1	D	A	
Quality factor	Score[b]	Slow hourly	Normal hourly	Sliding scale hourly; piece rate	Straight piece rate	Total
Fruit quality	1	0	0	0	0	0
	2	238	3	2	1	244
	3	81	26	15	9	131
	4	2	11	6	14	33
	5	0	0	0	3	3
Total		321	40	23	27	411
Pack condition	1	314	38	23	14	389
	2	7	3	0	5	15
Total		321	41	23	19	404
Berry condition	1	7	0	0	0	7
	2	306	39	22	23	390
	3	5	2	1	4	12
Total		318	41	23	27	409
Stem condition	1	180	11	3	4	198
	2	138	28	20	22	208
	3	0	0	0	1	1
Total		318	39	23	27	407
Berry size	1	1	0	0	0	1
	2	26	2	2	0	30
	3	118	6	9	0	133
	4	130	11	9	6	156
	5	44	19	2	16	81
	6	0	4	0	3	7
Total		319	42	22	25	408

(Continued on next page.)

Table 4 continued.

a/ Based on inspection and observation of fruit sold in the New York auction market during the 1951 season. For details concerning the study, see Ivan M. Lee and H. B. Richardson, Factors Related to Auction Price Premiums--Fresh Thompson Seedless and Tokay Grapes (Berkeley: University of California, College of Agriculture, Agricultural Experiment Station, January, 1954), 45p. (Giannini Foundation Mimeographed Report No. 160.)

b/ The scoring system for the quality characteristics included is as follows: Fruit quality: 1, excellent; 2, top good; 3, medium good; 4, low good; and 5, poor. Pack condition: 1, firm; 2, slack; 3, very slack; and 4, browning. Berry condition: 1, crisp; 2, firm; and 3, soft. Stem condition: 1, fresh; 2, pliable; and 3, dry. Berry size: gram weight per berry and corresponding scores were: 1, 2.9 grams; 2, 2.6 to 2.8 grams; 3, 2.3 to 2.5 grams, 4, 2.0 to 2.2; 5, 1.7 to 2.0 grams; and 6, below 1.7 grams.

over-all fruit quality, pack condition, and berry condition, it appears that fruit packed under wage plans E_1 and D scored slightly better than fruit packed under wage plan A. With respect to stem condition, wage plan E_1 makes a better showing than wage plans D and A. But, in regard to berry size, scores with wage plans E_1 and A appear to have about the same distribution, with berry size in both cases tending to be smaller than with wage plan D. These differences in distribution of scores--omitting scores for wage plan E_2--are statistically significant for the quality characteristics pack condition and berry size but are not statistically significant for the characteristics fruit quality, berry condition, and stem condition.[17]

While the statistical tests applied to the quality scores summarized in Table 4 indicate some correlation between quality ratings and packer wage plan, these results are presented with strong reservations. The small number of plants per wage plan and the small total number of plants result in an inadequate sample. And, as noted previously, variations in the quality of fruit reaching the packers from the field and variations in conditions in transit to the auction market may influence fruit quality ratings far more than differences in packing practices associated with a particular wage plan.

Shipping Point Inspection

An attempt to determine the influence of wage plans on quality was based on data from the inspection certificates issued by the California Bureau of Shipping Point Inspection during 1951 for the plants included in this study. Each certificate gives detailed information as to the characteristics of a sample of the fruit taken from the lot to which the certificate applies. Included are factors such as per cent of defective fruit, berry size, bunch size, color, sugar-acid content, and stem condition. An indication is given as to whether or not the fruit meets the standards required for a U. S. No. 1 grade.[18]

Nearly all of the inspection certificates indicated that the fruit inspected was of a U. S. No. 1 grade. Within that grade, however, there was an

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[17] With the data for the plants using wage plan E_2 omitted, a chi-square test under the hypothesis of no significant differences in quality scores for the plants using wage plans E_1, D, and A gives the following chi-square values: fruit quality, $\chi^2 = 14.6$; pack condition, $\chi^2 = 8.9$; berry condition, $\chi^2 = 2.6$; stem condition, $\chi^2 = 4.9$, and berry size, $\chi^2 = 26.4$. Critical chi-square values at the 5-per cent level of significance are 15.51, 5.99, 9.49, 9.49, and 18.31, respectively.

[18] U. S. Agricultural Marketing Service, U. S. Standards for Table Grapes, Washington, D. C., 1939.

indication as to whether the percentage of defects remaining in the fruit was "well within," "within," or "average within" grade. Well within means that the average percentage of defects is one half of the tolerance and no box exceeds the tolerance. Within means the average is within the tolerance and no box exceeds the tolerance. Average within means that the average is within the tolerance and no box exceeds $1\frac{1}{3}$ times the tolerance, if the tolerance is 10 per cent, and 2 times the tolerance if it is less than 10 per cent. For most defects and varieties, the tolerance is 10 per cent. On this basis, it is estimated that defects remaining average about 3 per cent for well within, 6 per cent for within, and 9 per cent for average within.

Estimated average percentages of defects remaining in the boxes packed in each plant are summarized in the third column of Table 5. In terms of averages, the plants paying flat piece rates tend to show a slightly higher percentage of defects than the hourly pay plants. However, looking at the data more closely in terms of individual plants, it is difficult to detect any significant difference according to wage plan.

For summer grapes (Table 5), two of the normal hourly plants--18 and 19--had very low percentages of defects. On the other hand, two slow policy hourly plants--6 and 7--where the lowest percentage of defects might have been expected rank about the same as the plants paying by flat piece rates. It is possible, however, that the data on the inspection certificates do not give the true picture of the over-all percentage of defects in the fruit in plants 6 and 7. A large part of the grapes packed in these plants apparently was not inspected, and it is possible that shipping point inspections were made only on fruit of doubtful quality.

For Emperor grapes (Table 5), one of the piece-rate plants--plant 9--had as few defects as the normal, hourly rate plant, and several other piece-rate plants--plants 13, 14, and 28--were very close to this figure. At the same time, the percentage of defects for the slow policy plant was again higher than for several of the piece-rate plants. In the Tokay plants, both the highest and lowest percentage of defects were found in plants paying a flat piece rate. Thus, it appears that a low percentage of defects can be attained in plants paying on a piece-rate basis as well as in plants paying by the hour. On the other hand, hourly rate pay is of itself no guarantee of a low percentage of defective fruit.

Table 5 also reveals that, on the average, a higher per cent of fruit was trimmed out as culls in plants paying packers constant hourly wages. This is

TABLE 5

Comparison of Direct Packing Labor Costs, Per Cent of Defects, and Costs of Packer Supervision Among a Sample of Plants Packing Emperor, Tokay, and Summer Grapes in California

Wage plan	Plant number	Packing labor cost per box[a]	Cull fruit	Defects, packed fruit[b]	Packer supervision labor[c]			
					Per packer hour		Per box	
					Hours	Cost[a]	Hours	Cost[a]
		cents	per cent			cents		cents
		Emperor grapes						
A. Flat piece rate	9	7.5	22	3.0	.111	21.6	.005	0.9
	10	7.7	20	7.3	.109	15.7	.007	1.0
	11	7.0	20	5.3	.060	11.1	.003	0.6
	13	8.0	32	3.7	.034	6.3	.002	0.3
	14	7.4	17	3.9	.031	3.5	.002	0.2
	22	7.0	12	5.9	.088	21.3	.003	0.8
	23	7.4	30	5.9	.069	13.1	.004	0.8
	25	7.5	30	5.0	.079	12.0	.005	0.7
	28	8.0	27	3.3	.094	18.8	.005	0.9
Average		7.5	23	4.7	.075	13.5	.004	0.7
D. Sliding scale hourly, then, piece rate	8	10.2	32	4.9	.055	7.3	.006	0.7
E_1. Hourly normal policy	18	13.9	30	3.0	.048	7.4	.007	1.0
E_2. Hourly slow policy	6	18.6	37	5.8	.058	5.9	.011	1.2
		Tokay grapes						
A. Flat piece rate	15	10.0	19	5.6	.055	9.6	.005	0.8
	17	10.0	18	3.1	.027	4.6	.002	0.4
	24	9.0	15	6.5	.073	11.0	.005	0.8
Average		9.7	17	5.1	.052	8.4	.004	0.7
B. Sliding scale hourly, plus piece rate	26	12.7	16	5.1	.046	8.0	.004	0.7
C. Flat hourly plus piece rate	20	12.2	29	4.2	.012	1.2	.001	0.1
		Summer grapes						
A. Flat piece rate	3	11.7	26	6.9	.062	10.2	.007	1.1
	14	12.3	26	6.1	.065	6.8	.006	0.7
	16	11.0	16	8.1	.088	9.3	.008	0.8
	25	7.5	27	6.0	.084	10.5	.007	0.9
	28	7.1	35	5.6	.088	17.3	.012	2.3
Average		9.9	26	6.5	.077	10.8	.008	1.2
D. Sliding scale hourly, then, piece rate	8	15.0	52	3.8	.041	5.7	.007	1.0
E_1. Hourly normal policy	2	16.2	17	6.2	.083	13.5	.013	2.1
	18	16.7	36	3.1	.046	7.2	.008	0.7
	19	22.3	38	3.0	.046	5.5	.010	1.2
Average		18.4	30	4.1	.058	8.7	.010	1.3
E_2. Hourly slow policy	6	26.5	40	6.5	.056	5.6	.015	1.5
	7	36.3	49	5.4	.096	10.0	.037	3.8
Average		31.0	45	6.0	.076	7.8	.026	2.7

[a] Actual cost per standard display lug reflects differences in pay scale, production, and overtime pay. Production data are from 1951 season, and costs are adjusted to 1953 wage level.

[b] Based on data from the California Bureau of Shipping Point Inspection.

[c] Includes foreladies, assistant foreladies, and packing line inspectors.

consistent with the theory advanced earlier that, as the amount of culls increases, packers may be less willing to spend the additional time on the heavier culling required to meet quality standards. Such a tendency, however, could be offset by wage adjustments to compensate for heavy culling. One solution would be to pay a constant hourly wage. Another possibility is to pay a modified incentive wage in conjunction with an hourly wage plan. For example, Table 5 indicates that plant 8--using a sliding scale hourly plan--had a very high percentage of culls removed and a low percentage of defective fruit remaining in the pack. Another possible modification is an upward adjustment in piece rates as the proportion of culls increases. As a practical matter, this probably would require a "step" adjustment for various ranges in the proportion of culls, rather than a continuous adjustment. Such a plan would reward efforts to maintain quality when higher culling rates were required, yet would maintain the average level of piece-rate earnings and provide incentive for individual workers to pack at higher rates of output than with an hourly wage plan. If an adjusted piece-rate plan were used, estimates of the proportion of culls probably should be based on a sample of trimmings by packer supervisors rather than on averages for the entire packing crew. Otherwise, individual packers might be encouraged to discard good fruit, unless excessive culling tended to reduce packer output.

Relation of Packer Supervision to Wage Plans and Quality

An important means of controlling the quality of the pack is in the amount of direct supervision and inspection labor employed. Costs and man-hours observed for this labor in the plants studied are given in the last four columns of Table 5. The labor requirements and costs are expressed on both a per packer hour and per-box basis. These data indicate that the costs of packer supervision vary considerably among plants. In terms of averages, the hours and costs of supervision per packer hour tend to be higher in plants paying flat piece rates than in those providing lesser wage incentives or paying constant hourly wages. Despite higher costs per packer hour, supervision costs per box tend to be a little lower in the piece-rate plants, particularly for Emperor grapes because of the higher rates of output with this wage plan.

While it seems likely that the amount of supervisory labor is an important factor in maintaining quality standards under the various wage plans, the data in Table 5 show no consistent relation between the amount of supervisory labor used and the percentage of defective fruit remaining in the packages. It is

true that the data indicate the use of about 20 per cent more supervisory labor in plants paying flat piece rates than in plants paying by the hour. This relationship, however, does not necessarily indicate the relative amounts of supervisory labor required under the two wage plans.

Whether or not supervisory labor can be effectively increased so as to offset completely all tendencies toward reduced quality under incentive plans is not certain. But it should be noted that the costs of this labor may be small compared to the differences in cost per box of fruit packed under a flat piece rate or a constant hourly rate wage plan.

SUMMARY AND CONCLUSIONS

This report presents the results of studies of packing fresh Emperor, Tokay, and summer grapes under several different packer wage plans. These include a straight piece-rate incentive wage plan, several modified incentive plans, and a constant hourly wage plan. The study indicates that variety of grape, proportion of cull fruit, packer wage plan, and type of packing equipment have an important bearing on packing costs and on packer productivity and earnings. The cost data presented refer to the costs of direct packing labor and the "indirect" costs of handling incoming fruit and culls and supplying fruit to the packers. Other costs not directly affected by the packer wage plan and the proportions of cull fruit--such as boxmaking, carloading, packing materials, and administrative expenses--are not considered in this report.

Consideration also is given to the possibility that the packer wage plan used has an effect on the quality of the packed fruit and on prices received.

While a detailed summary of the results is not attempted, their general nature may be illustrated with the following comments.

1. Packer productivity and packing costs. Several general relationships were emphasized by the studies, some of which are self-evident or revealed by casual observation. These are as follows:

   a. With a given proportion of cull fruit, average rates of packer output are higher with Emperor than with Tokay or summer grapes.

   b. Regardless of variety of grape, the rate of packer output declines as the proportion of cull fruit increases. Except with the straight piece-rate wage plan, this reduction in rate of output increases the per-box cost of direct packing labor. The costs of handling incoming fruit and culls and supplying fruit to the packers also rise because of the larger quantities of fruit handled.

c. With a given proportion of culls and the wage structure observed in this study, the rate of packer output is highest with a straight piece-rate wage plan and is lowest with a nonincentive, constant wage per hour. In terms of costs, this situation is reversed. The per-box costs of direct packing labor are lowest with the straight piece-rate wage plan and are highest with the constant hourly wage plan.

d. As the rate of output per packer increases, the "indirect" per-box costs of building space, equipment, and labor for handling incoming fruit and culls and supplying fruit to the packer are reduced. Differences in these costs due to type of packing equipment are relatively small.

The magnitude of the effects that variety of grape, per cent of culls, and wage plan have on costs per box can be illustrated with the following comparisons for Emperor and summer grapes. With Emperor grapes and 10 per cent culls, the costs of direct packing labor, plus the costs of handling incoming fruit and culls and supplying fruit to the packers with nonmechanized equipment, are estimated as 9.4 cents per box with the straight piece-rate wage plan (plan A) and 15.6 cents per box with the slow hourly rate plan (plan E_2)--a difference of 6.2 cents per box. With 40 per cent culls, these costs are 11.0 and 23.4 cents per box--a difference of 12.4 cents per box in favor of the piece-rate plan. With summer grapes, the per-box costs with 10 per cent culls are 12.4 cents with wage plan A and 21.6 cents with wage plan E_2--a range in costs of 9.2 cents per box. The corresponding costs with 40 per cent culls are 13.8 and 32.3 cents per box--a difference of 18.5 cents per box in favor of the piece-rate wage plan.

2. Packer earnings. With low or moderate amounts of cull fruit, earnings per packer hour are higher with incentive wage plans than with constant hourly wage plans. With heavy culling this situation is reversed. In packing summer grapes with 10 per cent culls, for example, packer earnings average $1.20 per hour when the piece rate is 10 cents per box, while hourly rate earnings are 95 cents per hour. With 40 per cent culls, however, piece-rate earnings at 10 cents per box are only 82 cents per hour in contrast with the constant hourly rate of 95 cents per hour. These relationships hold, of course, only for the wage structure specified. If--with a given per cent of culls--hourly wage rates were held constant and the piece rate reduced, piece-rate earnings for a given output would fall accordingly. A further reduction in earnings would also occur if rate of packer output dropped because of the reduced incentive. Similarly, other changes in the wage structure would change the level of earnings with a given wage plan as well as the relative earnings among all wage plans.

3. Wage plans versus quality. The relatively slow rates of output experienced with constant hourly rate wage plans in contrast with incentive plans might be presumed to help maintain the quality of the packed fruit. However, three different studies of this question--consisting of (1) comparisons of relative prices received in the auction market for fruit packed under the different wage plans, (2) similar comparisons of quality scores obtained on Thompson Seedless grapes sold in the New York auction in 1951, and (3) comparisons of grades of fruit shipped as reflected in inspections made by the Federal-State Inspection Service--failed to produce strong evidence to support this premise. The nature of the statistical data and the fact that many factors affecting quality ratings or relative prices are beyond the control of the packers make the results inconclusive.

4. Packer supervision. The amount and costs per packer for supervisory labor tend to be higher with the piece-rate wage plans than with the constant hourly rate plans. The costs of supervision per box, however, are lower with the piece-rate plans because of higher rates of output per packer hour. This is especially true with Emperor grapes. The evidence indicates that fruit quality standards were maintained under the incentive wage plans. Since greater amounts of supervisory help were used with the incentive wage plans, it is possible that adequate supervision is an important factor in the use of the incentive plans.

5. Conclusions. An unqualified conclusion from this study as to the best wage plan is not possible because clear evidence is lacking as to the effects of the various wage plans on the quality of pack and on prices received. However, the important benefits of incentive wage plans, in terms of lower costs to the firm and higher packer earnings per hour, suggest that plants paying constant hourly wages could well afford to consider alternative wage plans involving a wage incentive. Increased supervision and the use of modified incentive wage plans may provide a means of maintaining quality while providing gains to both packer and firm as the result of increased packer productivity.

APPENDIX A

Method of Estimating Rate of Packer Output in Relation to Wage Plan and Per Cent of Culls

The rates of packer output in relation to wage plan, variety of grape, and per cent of culls given in Figure 5 are based on an analysis of accounting records of packer output and proportions of cull fruit of 24 different packing plants. The data for each plant cover all, or a substantial part, of the 1951 packing season. Two approaches to the problem were made: one based on daily average rates of packer output and per cent of culls and the other on season averages for these two factors.

To illustrate the procedures used, daily average data for Emperor grapes showing the relationship between packer output and per cent of culls under different wage plans are given in Figure A. In this diagram, each point represents for a given wage plan the daily average output per packer hour in relation to daily average per cent of cull fruit. For each of the three wage plans illustrated, rate of output tends to fall as per cent of culls increases. This suggests that some estimate of average relationship between rate of output and per cent of culls can be established. In doing so with these data, however, two difficulties were encountered. One problem is the fact that the range in per cent of culls in some instances is rather narrow. A second difficulty is that substantial errors are believed to exist in the estimates of daily per cent of culls for some plants. This problem occurs with plants in which the cull-accounting period extended over periods of a week or more, with no reliable means of distributing the total cullage for the accounting period to particular days.

In view of the nature of the data available, a least-squares regression procedure for determining the average relationships did not seem appropriate. Instead, a procedure involving a logical assumption regarding the nature of these relationships was undertaken as follows:

1. Since, with 100 per cent culls, there could be no packer output, a curve representing the average relationships between rate of output and per cent of culls could be assumed to intersect the horizontal axis at a culling rate of 100 per cent.

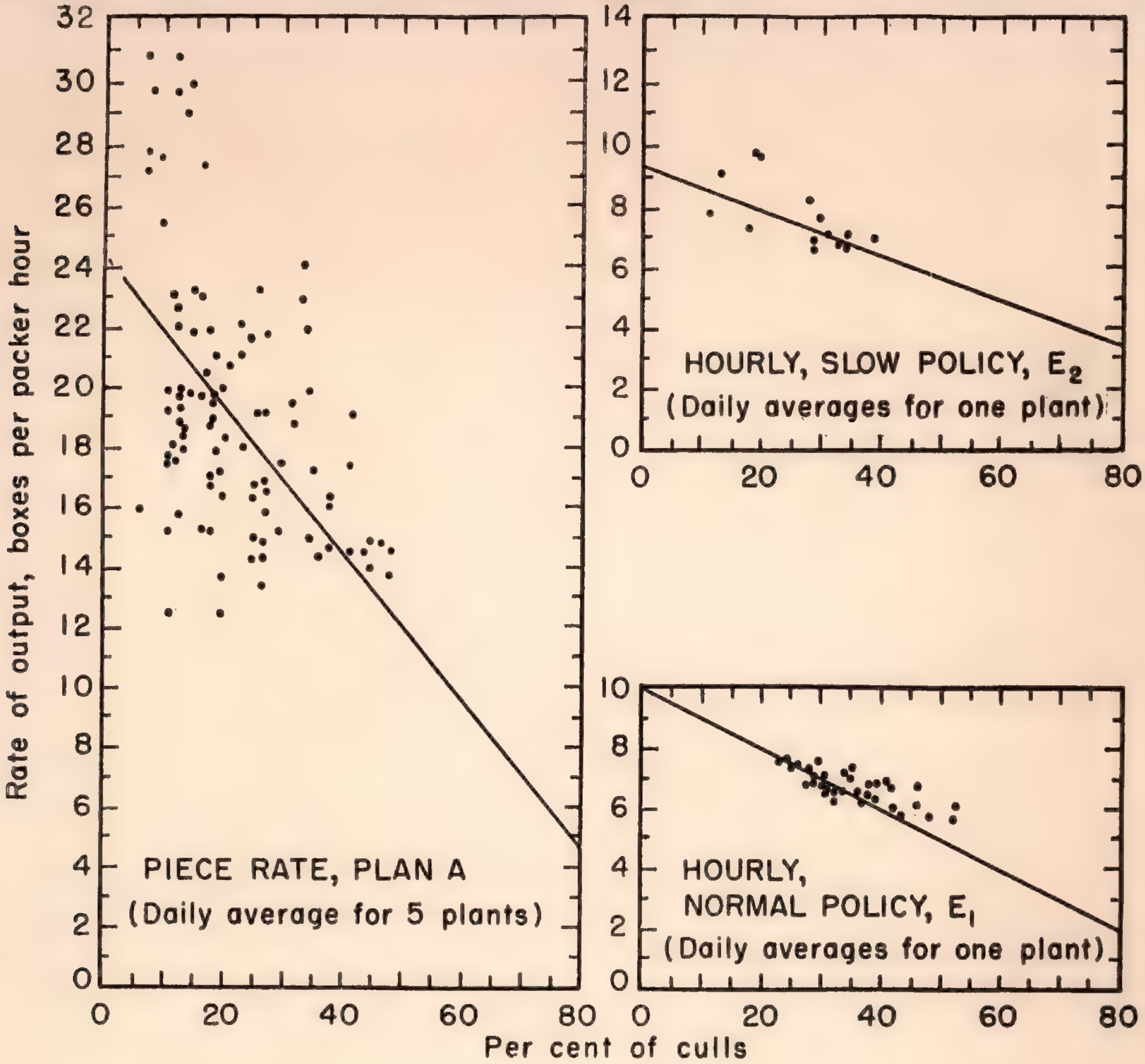

FIGURE A

The Effect of Wage Plan and Per Cent of Culls on Rate of Packing Emperor Grapes, Based on Daily Average Data

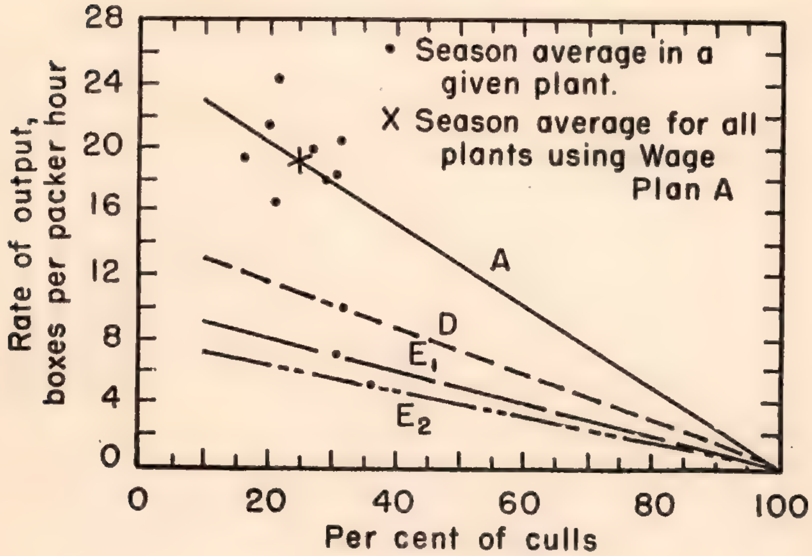

FIGURE B

The Effect of Wage Plan and Per Cent of Culls on Rate of Packing Emperor Grapes, Based on Season Average Data

2. With the above restraint, two alternative straight-line relationships were visualized as:[19] (1) a line passing through the 100-per cent cull point on the horizontal axis and the daily average values for packer output and per cent of culls or (2) a similar line passing through the season average values for rate of packer output and per cent of culls in each plant.

An average relationship of this type based on daily averages for rate of output and per cent of culls is represented by the sloping lines shown with each wage plan in Figure A. Similar results based on season averages for each plant are given in Figure B.

Comparison of equations obtained by the two procedures indicated that, for a given variety of grape and wage plan, the regression line based on season average data tends to be a little higher than that derived from the daily average data. This can be explained primarily in terms of the weighting procedure implicit in the calculation of the season averages. Days in which the plant worked long hours are given more weight than short days. Since higher rates of output tended to occur when fruit was in good supply and plant hours per day high, a line based on the weighted season average tends to be higher than one based on the unweighted daily averages. Since the accounting record data relative to per cent of culls were more reliable on a season average than on a daily average basis in some plants, the equations based on season average data have been used in the analysis. These equations are summarized in Table A.

Although other admissible assumptions would yield slightly different results, the assumptions used in developing the equations in Table A appear to be reasonable. The equations should provide an acceptable basis for estimating rates of packer output in relation to variety of grape, per cent of cull fruit, and wage plan, especially in the rarely exceeded range of 10 to 50 per cent culls.

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[19] It is recognized that the relationship between rate of packing and per cent of culls may be curvilinear rather than straight line, although there were no strong indications of this in the data.

TABLE A

The Effect of Variety of Grape, Wage Plan, and Per Cent of Culls on Rate of Packer Output (Regression Equations Based on Season Average Data, California 1951 Packing Season)

Variety	Wage plan[a]	Boxes packed per packer hour[b]
Emperor	A	P = 25.7 - .257C
	D	P = 14.5 - .145C
	E_1	P = 10.2 - .102C
	E_2	P = 8.24 - .082C
Tokay	A	P = 14.9 - .149C
	B	P = 13.7 - .137C
	C	P = 11.8 - .118C
Summer	A	P = 13.3 - .133C
	D	P = 11.9 - .119C
	E_1	P = 8.1 - .081C
	E_2	P = 5.7 - .057C

[a] For description of wage plans, see p. 4.

[b] P = boxes packed per packer hour and C = per cent of culls.

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